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(54) **LOCKING BRAKE FOR A SEAT ACTUATOR**

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F16H 19/08	(2006.01)
B60N 2/02	(2006.01)
B60N 2/16	(2006.01)
B60N 2/22	(2006.01)
B60N 2/44	(2006.01)

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CPC ***F16H 19/00*** (2013.01); ***B60N 2/0232*** (2013.01); ***B60N 2/168*** (2013.01); ***B60N 2/2227*** (2013.01); ***B60N 2/444*** (2013.01); ***F16H 19/02*** (2013.01); ***F16H 19/08*** (2013.01); *Y10T 74/188* (2015.01); *Y10T 74/18568* (2015.01)

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CPC . Y10T 74/188; Y10T 74/18568; F16H 19/00; F16H 19/08; F16H 19/02; B60N 2/0232; B60N 2/444; B60N 2/2227; B60N 2/168

See application file for complete search history.

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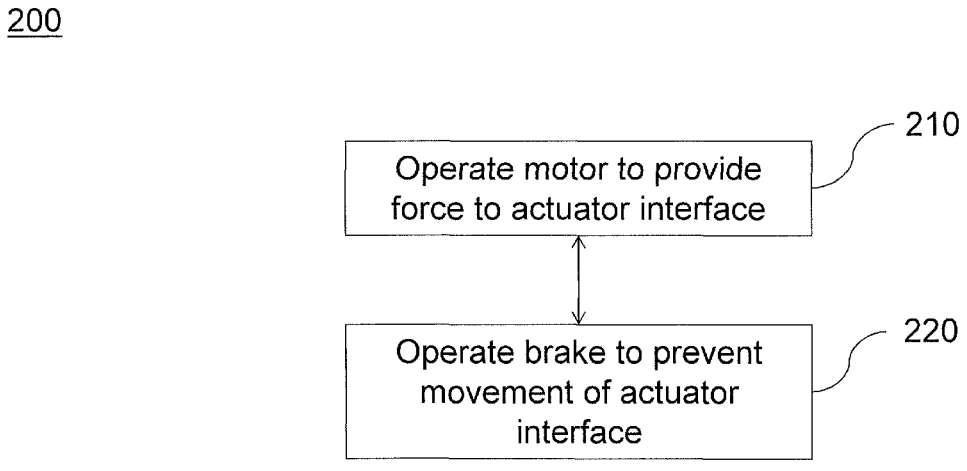
(57) **ABSTRACT**

Seat actuators and methods for operating seat actuators are disclosed. A seat actuator comprises an actuator interface, a motor, and a brake. The actuator interface is adapted to be coupled to a corresponding seat interface. The motor is operable to provide a force to the actuator interface. The brake comprises a plurality of interlocking components. The brake is operable to prevent movement of the actuator interface by a mechanical interlocking of the plurality of interlocking components. A method for operating the seat actuator comprises operating a motor of the seat actuator to provide a force to an actuator interface, and operating a brake to prevent movement of the actuator interface by mechanically interlocking a plurality of interlocking components of the brake.

17 Claims, 3 Drawing Sheets



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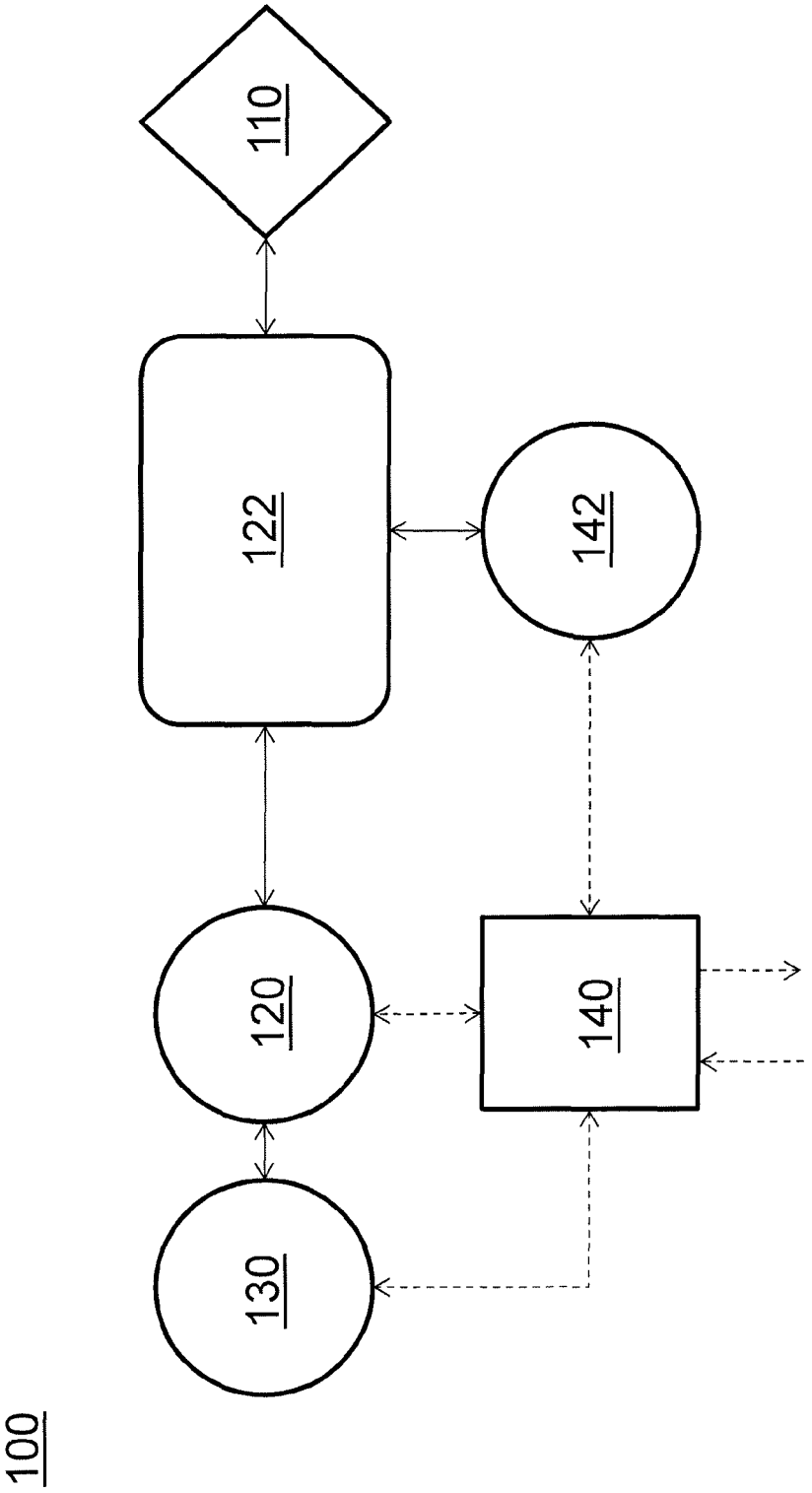

FIG. 1A

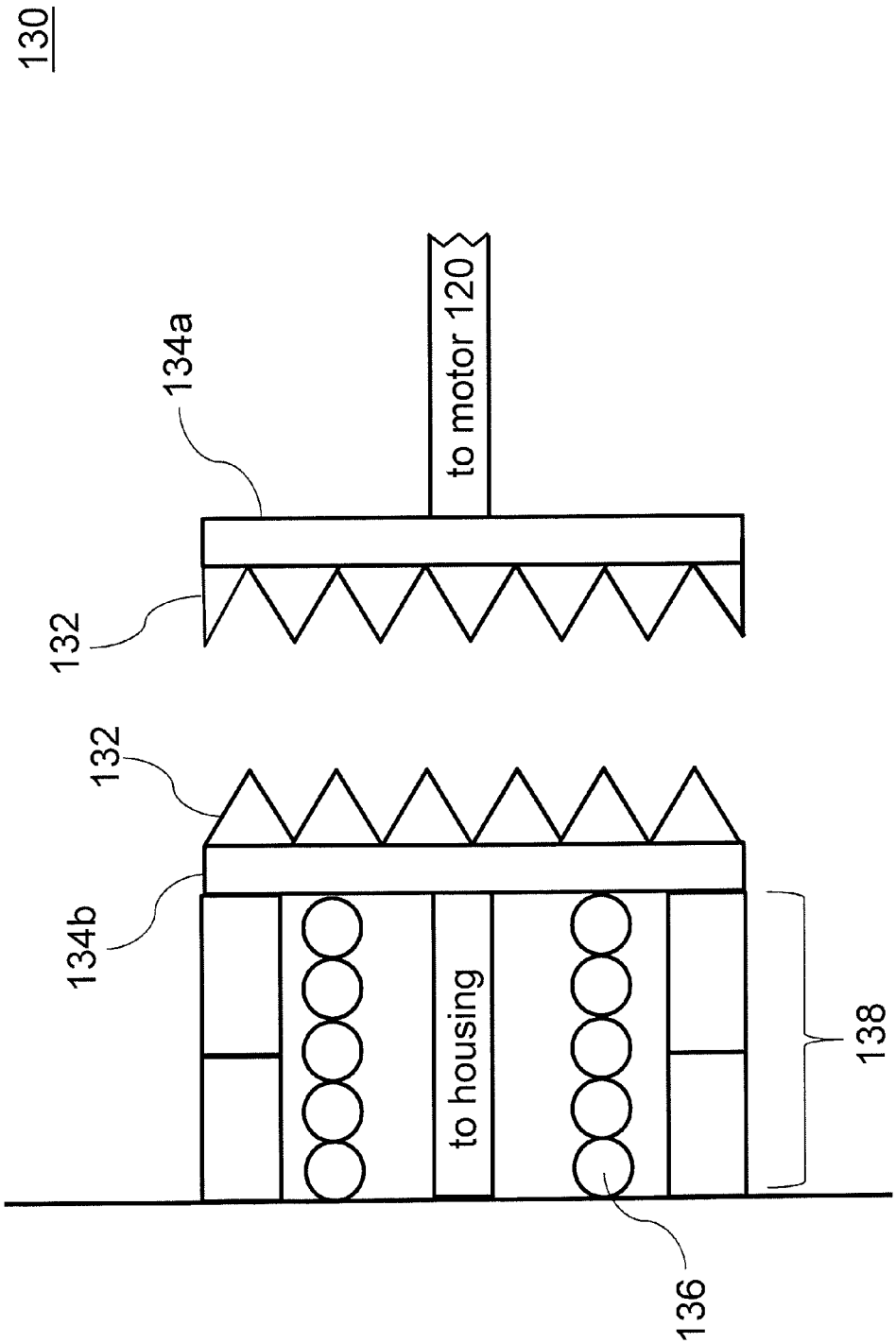

FIG. 1B

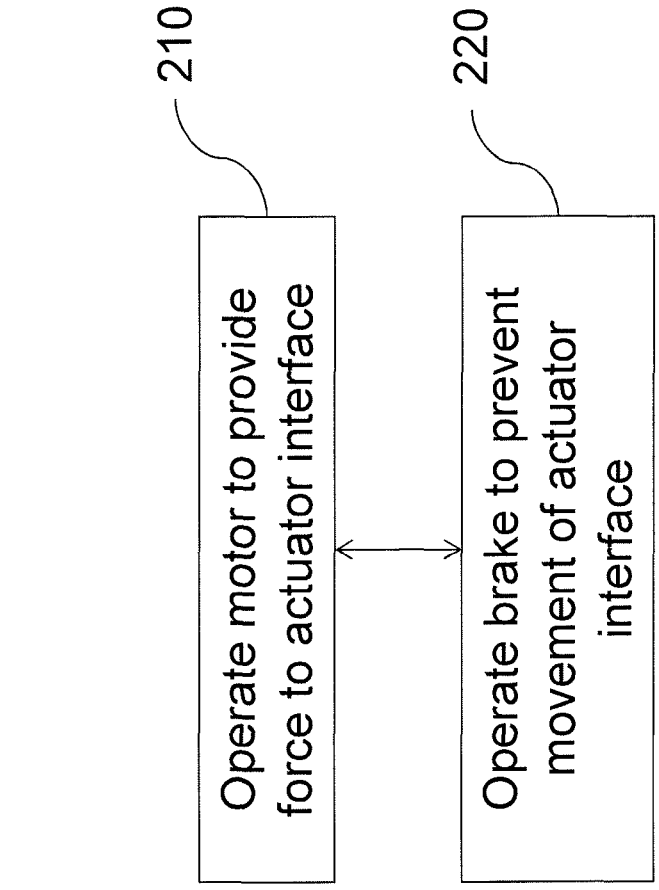
210
220
Operate motor to provide force to actuator interface
Operate brake to prevent movement of actuator interface
200

FIG. 2

LOCKING BRAKE FOR A SEAT ACTUATOR

CROSS-REFERENCE TO RELATED APPLICATIONS

The present application claims priority to U.S. Patent Application No. 61/581,260, filed Dec. 29, 2011, the contents of which are incorporated herein by reference in their entirety.

FIELD OF THE INVENTION

The invention relates generally to the field of actuators, and more particularly, to actuators for use with powered seats.

BACKGROUND OF THE INVENTION

In conventional seat actuators, friction brakes have been used to lock the position of the actuator in place. However, concerns have been raised over the use of friction brakes in aircraft seat actuators that must withstand crash loads. One proposed solution has been to use non-brackdriveable worm gears to address this concern. However, the use of these worm gears results in a gear train having a very low efficiency.

SUMMARY OF THE INVENTION

Aspects of the present invention are related to seat actuators and methods for operating seat actuators.

In accordance with one aspect of the present invention, a seat actuator is disclosed. The seat actuator comprises an actuator interface, a motor, and a brake. The actuator interface is adapted to be coupled to a corresponding seat interface. The motor is operable to provide a force to the actuator interface. The brake comprises a plurality of interlocking components. The brake is operable to prevent movement of the actuator interface by a mechanical interlocking of the plurality of interlocking components.

In accordance with another aspect of the present invention, a method for operating a seat actuator is disclosed. The method comprises operating a motor of the seat actuator to provide a force to an actuator interface, and operating a brake to prevent movement of the actuator interface by mechanically interlocking a plurality of interlocking components of the brake.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention is best understood from the following detailed description when read in connection with the accompanying drawings, with like elements having the same reference numerals. When a plurality of similar elements are present, a single reference numeral may be assigned to the plurality of similar elements with a small letter designation referring to specific elements. When referring to the elements collectively or to a non-specific one or more of the elements, the small letter designation may be dropped. According to common practice, the various features of the drawings are not drawn to scale unless otherwise indicated. To the contrary, the dimensions of the various features may be expanded or reduced for clarity. Included in the drawings are the following figures:

FIG. **1**A is a diagram illustrating an exemplary seat actuator in accordance with aspects of the present invention;

FIG. **1**B is a diagram illustrating an exemplary brake of the seat actuator of FIG. **1**A; and

FIG. **2** is a flowchart illustrating an exemplary method for operating a seat actuator in accordance with aspects of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

The embodiments of the invention described herein relate to brake mechanisms for a seat actuator. The disclosed embodiments include brake mechanisms with interlocking components, i.e., components that mechanically interlock in order to prevent movement of the seat actuator. While the embodiments of the present invention are described primarily with respect to actuators for powered seats, it will be understood that the invention is not so limited. The disclosed brake mechanisms may be used in all suitable actuators that may require or benefit from a secure brake mechanism.

The systems and methods described herein are particularly suitable for electrically energized actuators that may need to prevent movement under high stresses or forces. For example, the disclosed embodiments may be desirably used for seat actuators in airplane or automobile seats, in which the seats may experience high accelerations due to sudden movement (or stopping) of their associated vehicles. The actuators described herein may be particularly suitable for preventing movement of the actuator under such high loads.

Referring now to the drawings, FIGS. **1**A and **1**B illustrate an exemplary seat actuator **100** in accordance with aspects of the present invention. Actuator **100** may be usable to actuate a powered seat, e.g., in an airplane. As a general overview, actuator **100** includes an actuator interface **110**, a motor **120**, and a brake **130**. In FIG. **1**A, direct, mechanical couplings between components are shown with solid arrows, while electrical signal coupling between components are shown with dashed arrows. Additional details of actuator **100** are described herein.

Actuator interface **110** is adapted to be coupled to a corresponding seat interface. Actuator **100** is mounted to a seat frame at the location of the corresponding seat interface. When actuator interface **110** mates with the seat interface, actuator interface **110** transmits the power generated by actuator **100** to the seat via the seat interface, in order to generate a desired movement of the seat. Suitable actuator interfaces **110** will be known to one of ordinary skill in the art, and may be selected based on the corresponding seat interface provided on the seat and/or the type of seat movement intended to be generated by actuator **100**.

Motor **120** is operable to provide a force to actuator interface **110**. Motor **120** may be coupled to actuator interface **110** directly (e.g., via a motor shaft) or indirectly (e.g., via gear train **122**, as shown in FIG. **1**A). Motor **120** may receive power from a power source that is external from actuator **100**, and to which actuator **100** is electrically connected. Alternatively, actuator **100** may include an internal power source (not shown) such as a battery for powering motor **120**. Suitable motors for use as motor **120** will be known to one of ordinary skill in the art from the description herein.

Brake **130** is operable to prevent of the actuator interface **110**. Brake **130** prevents movement of actuator interface **110** via the connection between motor **120** and actuator interface **110**. Accordingly, brake **130** further prevents motor **120** from providing any force to actuator interface **110**.

Brake **130** comprises a plurality of interlocking components **132**, as shown in FIG. **1**B. In an exemplary embodiment, brake **130** comprises a pair of discs **134***a* and **134***b*. A first disc **134***a* is attached to a shaft of motor **120**, and a second disc **134***b* is attached to the housing of actuator **100**. The plurality of interlocking components **132** are formed on

opposing surfaces of the pair of discs **134***a* and **134***b*. In an unlocked position, the interlocking components **132** on first disc **134***a* do not contact the interlocking components **132** on second disc **134***b*, and accordingly, first disc **134***a* is free to rotate along with the shaft of motor **120**. In a locked position, the interlocking components **132** on first disc **134***a* mechanically interlock (or mate) with the interlocking components **132** on second disc **134***b*, and thereby prevent rotation of first disc **134***a* and the shaft of motor **120**.

In the manner outlined above, brake **130** is operable to prevent movement of actuator interface **110** by preventing movement of motor **120**. When brake **130** is in the locked position, the shaft of motor **120** is prevented from rotating (relative to the housing of actuator **100**, to which second disc **134***b* is attached). This restriction in movement is transmitted to the actuator interface **110** via the connection between motor **120** and actuator interface **110** described above. For example, if motor **120** is directly connected to actuator interface **110** (e.g., via the motor shaft), then actuator interface **110** is prevented from movement through its direct connection to the motor shaft. For another example, if motor **120** is indirectly connected to actuator interface **110** (e.g., via gear train **122**), then gear train **122** is prevented from movement through is direct connection to the motor shaft, and actuator interface **110** is prevented from movement through its direct connection to gear train **122**.

As shown in FIG. **1**B, the plurality of interlocking components **132** may comprise a set of mechanical teeth that are configured to mate with each other when brake **130** is placed in a locked position. However, the invention is not so limited. Interlocking components **132** may comprise any structural components having any structure shapes sufficient to prevent relative rotation of the first disc **134***a* relative to the second disc **134***b*. Other suitable structures will be known to one of ordinary skill in the art from the description herein.

Brake **130** receives power from an external or an internal power source, substantially as described above with respect to motor **120**. It may be desirable that brake **130** be automatically placed in the locked position when in an unpowered state. In an exemplary embodiment, brake **130** comprises a spring element **136**. Spring element **136** exerts a force on one half of the plurality of interlocking elements **132** (e.g., on second disc **134***b*) in order to maintain the plurality of interlocking components **132** in the locked position, e.g., when no power is applied to brake **130**. Brake **130** further comprises a magnetic release mechanism **138**. Magnetic release mechanism is configured to counteract the force provided by spring element **136** when it receives power. Accordingly, magnetic release mechanism **138** reverses the bias provided by spring element **136**, and releases the plurality of interlocking components **132** from the locked position.

Seat actuator **100** is not limited to the above described components, but may include alternative or additional components, as would be understood by one of ordinary skill in the art.

For example, actuator **100** may include a gear train **122**. Gear train **122** is coupled to both motor **120** and actuator interface **110**. Gear train **122** transmits the force generated by motor **120** to actuator interface **110**. As set forth above, gear train **122** couples motor **120** to actuator interface **110** in a force-transmissive manner; in other words, when motor **120** is prevented from movement (i.e. by brake **130**), actuator interface **110** is prevented from movement. Gear train **122** may be configured to provide either a rotary force or a linear force to actuator interface **110** depending on the corresponding seat interface and the intended use of actuator **100**.

For another example, actuator **100** may include an actuator controller **140**. Actuator controller **140** controls the operation of the components of actuator **100**. In particular, actuator controller **140** may control the operation of actuator **100** based on received signals. In an exemplary embodiment, actuator controller **140** is adapted to receive a signal representing a desired seat movement. Actuator controller **140** receives data through one or more connectors. The signal may be generated by a centralized controller, by a user input, or may represent a preset seat position stored in a memory of actuator controller **140**. Where actuator controller **140** receives signals from an external source, actuator controller **140** may require only a subset of the data for controlling a particular seat movement, for example, where a seat includes a plurality of seat actuators **100** for performing different seat movements or for coordinating on the same movement of the seat.

Upon receipt of the signal, actuator controller **140** is configured to control motor **120** to provide the force to actuator interface **110** based on the received signal. Alternatively, actuator controller **140** is configured to operate brake **130** to be in the locked or unlocked position based on the received signal. Actuator controller **140** may further include a potentiometer **142** configured to provide feedback on the movement of the seat to actuator controller **140**. This feedback may be used to refine the control of motor **120** and/or brake **130** to match the desired movement indicated by the received signal.

It may be particularly desirable that motor **120** not be operated when brake **130** is in the locked position, and/or that brake **130** not be placed in the locked position when motor **120** is operating. This may be desirable in order to prevent damage to motor **120** or brake **130**. Accordingly, actuator controller **140** may be configured to incorporate a delay between operation of these components in order to prevent the components from being operated simultaneously. In an exemplary embodiment, actuator controller **140** is programmed to operate motor **120** only after a predetermined period of time following operation of brake **130** to be in an unlocked position. Likewise, actuator controller **140** is programmed to operate brake **130** to be in a locked position only after a predetermined period of time following operation of motor **120** to stop moving (i.e. stop providing the force to actuator interface **110**).

Where actuator **100** does not include an actuator controller **140**, control of the components of actuator **100** may be provided by a centralized controller separate from actuator **100** and configured to control the operation of multiple seat actuators.

FIG. **2** illustrates an exemplary method **200** for operating a seat actuator in accordance with aspects of the present invention. Method **200** may be performed by to actuate a powered seat, e.g., in an airplane. As a general overview, method **200** includes operating a motor to provide force to an actuator interface, and operating a brake to prevent movement of the actuator interface. Additional details of method **200** are described herein with respect to seat actuator **100**.

In step **210**, a motor of the actuator is operated. In an exemplary embodiment, motor **120** of actuator **100** is operated to provide a force to actuator interface **110**. As set forth above, motor **120** may provide the force to actuator interface **110** directly (e.g., via a motor shaft) or indirectly (e.g., via gear train **122**, as shown in FIG. **1**A).

In step **220**, a brake of the actuator is operated. In an exemplary embodiment, brake **130** of actuator **100** is operated to prevent movement of actuator interface **110** by mechanically interlocking the plurality of interlocking components **132** of brake **130**. As shown in FIG. **1**B, the inter-

locking components **132** on first disc **134***a* mechanically interlock (or mate) with the interlocking components **132** on second disc **134***b*, and thereby prevent rotation of first disc **134***a* and the shaft of motor **120**. This restriction in movement is transmitted to the actuator interface **110** via the connection between motor **120** and actuator interface **110** described above.

As set forth above, it may be particularly desirable that motor **120** not be operated when brake **130** is in the locked position, and/or that brake **130** not be placed in the locked position when motor **120** is operating. Accordingly, step **210** may comprise operating the motor only after a predetermined period of time following operation of the brake to be in an unlocked position. Likewise, step **220** may comprise operating the brake to be in a locked position only after a predetermined period of time following operation of the motor to stop providing a force to the actuator interface.

Method **200** is not limited to the above described steps, but may include alternative or additional steps, as would be understood by one of ordinary skill in the art.

For example, in the embodiment in which brake **130** comprises spring element **136** and magnetic release mechanism **138**, method **200** may comprise the steps of maintaining the plurality of interlocking components **132** in a locked position when brake **130** is in an unpowered state, and operating magnetic release mechanism **138** in order to release the plurality of interlocking components **132** from the locked position.

For another example, in the embodiment in which actuator **100** comprises actuator controller **140**, method **200** may comprise the steps of receiving a signal representing a desired seat movement, and operating motor **120** and/or brake **130** based on the received signal. As set forth above, actuator controller **140** may be configured to control motor **120** to provide the force to actuator interface **110** based on the received signal. Alternatively, actuator controller **140** may be configured to operate brake **130** to be in the locked or unlocked position based on the received signal.

Although the invention is illustrated and described herein with reference to specific embodiments, the invention is not intended to be limited to the details shown. Rather, various modifications may be made in the details within the scope and range of equivalents of the claims and without departing from the invention.

What is claimed:

1. A seat actuator for a vehicle seat comprising:

a motor having an output shaft operable to move the vehicle seat; and

a brake comprising a plurality of interlocking components, the brake operable to prevent rotation of the output shaft of the motor by mechanical interlocking of the plurality of interlocking components, the plurality of interlocking components comprising a set of mechanical teeth, one subset of the set of mechanical teeth fixedly connected to a housing of the seat actuator and the other subset of the set of mechanical teeth connected to the output shaft of the motor,

wherein, in an unpowered state of the seat actuator, the subsets of mechanical teeth are engaged together to prevent rotation of the output shaft, and in a powered state of the seat actuator, the subsets of mechanical teeth are disengaged to permit rotation of the output shaft.

2. The seat actuator of claim **1**, wherein the brake comprises a spring element for maintaining the plurality of interlocking components in a locked position.

3. The seat actuator of claim **2**, wherein the brake comprises a magnetic release mechanism for releasing the plurality of interlocking components from the locked position.

4. The seat actuator of claim **1**, further comprising an actuator controller adapted to receive a signal representing a desired seat movement, and operable to control the motor based on the received signal.

5. The seat actuator of claim **4**, wherein the actuator controller is further operable to control operation of the brake.

6. The seat actuator of claim **5**, wherein the actuator controller is programmed to operate the motor only after a predetermined period of time following operation of the brake to be in an unlocked position.

7. The seat actuator of claim **5**, wherein the actuator controller is programmed to operate the brake to be in a locked position only after a predetermined period of time following operation of the motor to stop providing the force.

8. The seat actuator of claim **4**, wherein the received signal is generated by a user input.

9. The seat actuator of claim **1**, wherein the brake comprises a pair of discs, and the plurality of interlocking components are formed on opposing surfaces of the pair of discs.

10. A method for operating a seat actuator of a vehicle seat comprising:

operating an output shaft of a motor of the seat actuator to move the vehicle seat; and

operating a brake to prevent rotation of the output shaft of the motor by mechanically interlocking a plurality of interlocking components of the brake, the plurality of interlocking components comprising a set of mechanical teeth, one subset of the set of mechanical teeth fixedly connected to a housing of the seat actuator and the other subset of the set of mechanical teeth connected to the output shaft of the motor.

11. The method of claim **10**, further comprising the steps of:

maintaining the plurality of interlocking components in a locked position when the brake is in an unpowered state; and

operating a magnetic release mechanism in order to release the plurality of interlocking components from the locked position.

12. The method of claim **10**, wherein the step of operating the motor comprises operating the motor only after a predetermined period of time following operation of the brake to be in an unlocked position.

13. The method of claim **10**, wherein the step of operating the brake comprises operating the brake to be in a locked position only after a predetermined period of time following operation of the motor to stop providing the force.

14. The method of claim **10**, further comprising the steps of:

receiving a signal representing a desired seat movement; and

operating the motor and/or operating the brake based on the received signal.

15. A seat actuator for a vehicle seat comprising:

a motor having an output shaft operable to move the vehicle seat; and

a brake comprising a plurality of interlocking components, the brake operable to prevent rotation of the output shaft of the motor by mechanical interlocking of the plurality of interlocking components, the plurality of interlocking components comprising a set of mechanical teeth, one subset of the set of mechanical teeth fixedly connected to

a housing of the seat actuator and the other subset of the set of mechanical teeth connected to the output shaft of the motor,

wherein, in an locked state of the brake, the subsets of mechanical teeth are engaged together to prevent rotation of the output shaft, and in an unlocked state of the brake, the subsets of mechanical teeth are disengaged to permit rotation of the output shaft.

16. The seat actuator of claim **15**, wherein in an unpowered state of the seat actuator, the brake is automatically placed in the locked position.

17. The seat actuator of claim **15**, wherein the brake comprises a spring element for maintaining the plurality of interlocking components in the locked position.

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